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RECENT WORK OF THE U. S. GEOLOGICAL SURVEY IN ALASKA.

BY

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In keeping with the annual appropriations made by the Congress for the purpose, the work of the U. S. Geological Survey in Alaska, begun in 1895, has been vigorously prosecuted up to the present time. Though the results of each season's work have appeared almost immediately in the published reports and maps of the bureau, the rapid growth of the country and the development of various mining regions with reference to gold, copper, coal, and oil have rendered the demand for geographic and geologic information, in many instances, much beyond the power of the Survey with its present force to supply. During the past season, 1901, four parties were in the field, respectively in southeastern Alaska, Seward peninsula, the Kobuk river region, and northern Alaska and the Arctic coast.

SOUTHEASTERN ALASKA.—In the relatively well-known region of southeastern Alaska, also known as the *panhandle* of Alaska, embracing the scenic Alexander archipelago and neighbouring fiords, inlets, and peninsulas, the work was in charge of geologists Alfred H. Brooks and C. C. Brayton. Here the work was more economic, and of a less explorational and geographic character, than in the northern regions. Considerable attention was devoted to Prince of Wales Island, where the mineral deposits were visited and examined, as were also those in the Sitka, Ketchikan, Juneau, and Skagway vicinities, where development work had been done.

SEWARD PENINSULA.—Recognition of the prospective extension of the Nome gold fields to the northward made it urgent that last year's (1900) work of the Survey* in the southern part of the peninsula should be continued as far as possible in the northern part in 1901. This work in the northern part of the peninsula, in charge of T. G. Gerdine and D. C. Witherspoon, topographers, and A. J. Collier, geologist, accordingly consisted in making a topographic and geologic survey of the western central part of the peninsula lying essentially to the north of Port Clarence, Grantley Harbour, and the Imuruk basin. The area lies between the 65th and 66th parallels, and the 164th and 168th meridians. The outline is roughly equilaterally triangular, with an apex extending westward to near Cape Prince of Wales, the most westerly point of the American continent.

ITINERARY AND METHOD OF WORK.—Transportation in the field was essentially by pack train, and to some extent by boat. The party and outfit destined for Port Clarence arrived in the roadstead off Nunivak Island in latitude 60° on the S.S. *Senator*, June 9, but was delayed by the pack ice in Bering Sea until June 16, when a landing was effected at Nome. Owing to the lateness of the spring, the surrounding mountains were still white, and snowdrifts were in the streets of Nome. Heavy teaming was still going on over the firm ice at Port Clarence and Grantley Harbour. Vegetation had not yet started. Not until July 12 could the season's field work be begun at Teller City, near the entrance to Grantley Harbour, where the signals erected by the U. S. Coast and Geodetic Survey were repaired, and from these, as a base, a system of triangulation was expanded over the northern part of the peninsula.

From Teller the work was carried westward to the Don Carlos river, thence northward by way of a pass at the head of this river, and around the northern side of the York mountains to York. From this point the route of work was northeastward toward Ear Mountain, then southeastward to the head of steamboat navigation on the Kuzitrin river in latitude 65° 10′, where a cache of supplies had been sent earlier in the season. From here a detachment proceeded westward to map the lower Agiapuk drainage, while the remainder of the party proceeded northward as far as Midnight Mountain, latitude 65° 48′, and thence returning southward, reached Nome September 13.

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* Reconnaissances in the Cape Nome and Norton Bay Regions, Alaska, in 1900. U. S. Geological Survey.

Owing to great scarcity of grass, due to the unusual coldness of the summer, it was necessary to carry horse feed throughout the season. During the progress of the work many side trips were made by detachments, while the main camp moved slowly. In execution, the work, especially its topographic side, was much delayed by rain and fog. But the season's effort resulted in the completion of a much-needed topographic map of the region, with a contour interval of 200 feet, and covering an area of nearly 5,000 square miles; and the collection of important physiographic, economic and geologic data.

MOUNTAINS AND PLATEAU.—The Kigluaik or Sawtooth Mountains, trending east and west along the southeastern edge of the area on the 65th parallel, are the highest mountains of Seward peninsula, attaining an elevation of 4,700 feet. This mountain axis is continued eastward in the Bendeleben range, which rises to a height of 3,700 feet at its highest point. North of this mountain axis the upland surface in general has the character of a warped and dissected plateau, whose middle portion has a maximum elevation of about 1,500 feet, whence the sloping surface at some points along the northern and southern margins descends to sea-level. Upon this plateau occur a number of mountains and buttes, with no definite system of arrangement. The most prominent of these are the York Mountains, consisting of an approximately circular, rugged group, covering an area of nearly 100 square miles, the highest point of which rises to about 3,000 feet. These buttes and mountains are of the Monadnock type, the most prominent being Mounts Mukacharni, Cape, Conical, Kugrug, Midnight, and Devil, attaining elevations of from 1,200 to 3,000 feet. Some of these were approximately located and named on Capt. Beechey's chart of 1826.

COASTLINE—COASTAL AND LACUSTRINE PLAINS.—On the north the upland merges with a broad coastal plain, which is bordered by extensive tidal lagoons, enclosed by wave-built barrier beaches. On the south, for twenty miles eastward from Cape Prince of Wales, the plateau is bounded by steep slopes and sea-cliffs, while farther eastward the surface slopes gently to tide-level, merging with the alluvial and lacustrine plains of the Imuruk and Kuzitrin basins. Imuruk Bay, or Salt Lake, as it is locally called, occupies a broad depression on the north side of the Kigluaik Mountains, which rise abruptly from its edge. The Kuzitrin basin is a somewhat similar depression, having a like relation to the Bendeleben range on the south. It is filled with lacustrine deposits, through which the Kuzitrin river extensively meanders before entering the slight cañon through which it flows on to Imuruk Bay.

Drainage.—The drainage of this area is somewhat remarkable, in that the two largest and longest rivers, the Agiapuk and the Kuzitrin—the former rising quite near the coast on the north—flow southward directly toward, instead of from, the highest mountain mass of the peninsula. Both flow into Imuruk Bay, thence through Grantley Harbour and Fort Clarence into Bering Sea. The Agiapuk has a drainage of nearly 800 square miles and the Kuzitrin approximately 1,200. East of the York Mountains a number of small streams flow southward into Port Clarence, while to the west of the same other shorter drainages flow southward into Bering Sea.

Heading against the Kuzitrin drainage on the north, in the northeast part of the area, the Serpentine river flows northward into Shishmaref Inlet. The remainder of the drainages, mostly flowing northwestward into the Arctic Ocean, are, in general, short. The Kuzitrin, Agiapuk, and Serpentine rivers are navigable for small river steamers for a few miles above the mouth. All are used by rowboats for the transportation of supplies.

Population.—Besides the sparse native population of Eskimos, scattered along the coast and extending inland along Imuruk Bay and Kuzitrin river, the discovery of gold in nearly all parts of the area gave to the region during the summer of 1901 an additional population of nearly 3,000 whites. This consisted mostly of prospectors, miners, and trading people. Though widely spread, some of its principal centres were Teller, with a population of 2,000; Mary's Iglo, at the head of steam navigation on the Kuzitrin, 150; Candle Creek, 100; Dall Creek, 100; York, 50. Mining operations were in progress on the Kuzitrin, Agiapuk, and other drainages of the region, and much interest directed to new discoveries made to the northeastward in the Good Hope Bay country. There is a Lutheran Mission at Port Clarence and a Congregational Mission at Cape Prince of Wales. Each has a herd of 1,000 or more reindeer.

Fish and Game.—Salmon are abundant in the Imuruk drainages. Grayling and trout are also present. The principal bird is the ptarmigan. A few very wild caribou were seen in the northern part of the region.

THE KOBUK RIVER REGION.—The Kobuk has a large drainage basin in northwestern Alaska above the Arctic Circle. It heads east of the 155th meridian, and, trending westward roughly along the 67th parallel, opens into Kotzebue Sound, a large arm of the

Arctic Ocean near the 162d meridian. The work here, in charge of W. C. Mendenhall, geologist, and D. L. Reaburn, topographer, besides making a reconnaissance survey through the above region, consisted also in carrying a line from the Yukon into the Koyukuk and thence into the Kobuk, the main field of work.

Itinerary and Methods of Work.—Transportation was essentially by drainage ways and by portage. On May 27 the party, consisting of seven men, proceeded from Skagway over the coast range by rail to White Horse, the interior terminus of the White Pass Railway, thence by canoes down Fifty-Mile River on the 29th to the head of Lake Lebarge. Though the river had cleared, the great body of ice, a foot or more in thickness, on Lake Lebarge, had not yet moved. As time was urgent, however, the lake was passed by working the canoes down a narrow, discontinuous waterway along the western shore and sledging or dragging them over the unbroken ice where necessary. From lower Lebarge transportation was by river steamboat to Fort Yukon, a point of known astronomic location, whence the topographic work was taken up and carried by stadia 200 miles down the Yukon to Fort Hamlin, near the edge of the Yukon flats, also a point of known astronomic position, being a little south of the 66th parallel. The stadia check between these two points was substantially correct; but intermediate portions of the river, which had been previously mapped by crude sketches only, were found to be considerably in error.

From Fort Hamlin, the point of departure from the Yukon, the work, continued by combination of triangulation, stenometer, and stadia, was carried northward up the Dall river, thence by portage across the divide to Old Man Creek, which was descended by canoe to Bergman, on the Koyukuk, near the Arctic Circle. Bergman was reached July 14, at a distance of 300 miles from Fort Hamlin, and the work connected with that done by the Survey here in 1899* and that in northern Alaska on the Arctic coast in 1901. Here canoes and supplies had been shipped during the previous season and stored for the Kobuk river work. Accordingly, after re-outfitting, the traverse was continued northward up the Allen river, a distance of 80 miles; thence westward up one of its tributaries, known as Help-me-Jack Creek; thence by a portage of 5½ miles to the Chekayakaka, a tributary of the Kobuk river, whose waters finally flow into Kotzebue Sound. The descent of the Chekayakaka with the work was begun August 8, and the main

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* Reconnaissance along the Chandlar and Koyukuk rivers, Alaska. U. S. Geological Survey, 1899.

Kobuk soon reached, down which the work was carried to Quaker Mission on Kotzebue Sound, one portage being made *en route* around a rough section of the river.

On Kotzebue Sound the work was continued southward along the eastern shore by way of Choris Peninsula and Chamisso Island to the new mining settlement of Deering, near Cape Deceit, in Good Hope Bay, where the season's work closed, and whence by ocean vessel the party reached Nome September 29.

GEOGRAPHIC.

FROM THE YUKON TO THE KOYUKUK.—The belt of country, more than 100 miles in width, traversed by the work between the Yukon and the Koyukuk, is largely occupied by a long ridge of generally low mountains and hills given off by, and extending to and southeastward from, the great Trans-Alaskan mountain range on the north, which forms the watershed between the drainages of the Arctic Ocean on the north and those of the Yukon on the south. This region, composed essentially of metamorphic rocks, is for the most part one of considerable relief, comparable to the district through which the Yukon has cut the well-known lower ramparts, the hills rising to an elevation of 3,000 or more feet, or from 500 to 1,000 feet above the timber-line. Above this line they are often barren of vegetation, being covered by rock débris. The tops in the main are rounded, having smooth, flowing contours. A district somewhat north of Old Man Creek portage, however, contains many rugged forms, giving the character of a true Rocky Mountain topography. On the northwest the surface slopes off into a gently rolling plateau country toward the Koyukuk, and is underlain for the most part by younger formations of sandstones and slates of probably Mesozoic Age, to which the name Bergman series has been applied.

DALL RIVER.—The lower 60 miles of the Dall river lie in extensive flats, which are continuous with the Yukon flats, while the upper part lies in the hilly or low mountainous country above described. Where this hilly country meets the flats, the river flows in a gorge or cañon, at whose mouth the overland pack trail from Fort Hamlin to the Koyukuk crosses the river. At ten or fifteen miles below this point the general level of the flats is interrupted by low silt and gravel mounds a couple of hundred feet in height. The length of portage from Dall river to Old Man Creek is approximately 18 miles, and coincides for the first ten miles of that distance with the Yukon-Fish-Creek trail.

OLD MAN CREEK.—Old Man Creek is approximately 200 miles in length. It trends a little north of west, and enters the Koyukuk a few miles below Bergman, near the Arctic Circle. It heads in a barren, rocky region, and has at first a torrential gradient; but soon, at an elevation of about 1,400 feet, enters a small basin some 15 miles in length, through which it meanders sluggishly in flats. At the lower end of these flats, however, it again enters a gorge nearly 20 miles in length, in the course of which it falls nearly 800 feet, the entire distance being a series of riffles and rapids, very difficult to navigate and seriously dangerous to boats. Below this gorge the stream enters another series of flats, far more extensive than the above. These in turn are succeeded by a cañon cut in the Bergman formation of sandstones and slates, and continuing nearly to the Koyukuk. But here the stream, not so torrential, is readily navigable.

ALLEN RIVER.—The Allen river enters the Koyukuk from the north a few miles above the Arctic Circle. It is one of its largest tributaries, and can be ascended for 30 or 40 miles by small steamboats. It heads in the Trans-Alaskan mountains, near the 68th parallel, whence its general trend is considerably east of south. Its length somewhat exceeds 100 miles. Along its lower course it occupies a valley from 5 to 10 miles in width, bounded on either side by irregular hills rising from a few hundred to 2,000 feet above the river. These hills are composed essentially of the Bergman sandstone series, already noted. The flats in this section of the valley have a width of 3 to 10 miles and an extent of 25 miles above the mouth. For size and number the meanders made by the river through these flats are exceptionally striking.

HELP-ME-JACK CREEK.—Help-me-Jack Creek is a western tributary of the Allen, which heads in a broad valley near the Chekayakaka, a tributary to the Kobuk. The portage, which is about six miles in length, rises to an elevation of 1,100 feet. It has long been used by the natives in passing from the Kobuk to the Koyukuk drainages.

KOBUK RIVER.—The valley of Help-me-Jack Creek, especially its upper portion, lies largely in metamorphic rocks, older than the Bergman series. The upper ten miles of the creek were found to be very shoal. While making the portage, however, early in August, the rainy season opportunely set in, yielding ample water for the descent of the rocky Chekayakaka, a distance of 10 miles to the Kobuk. Here the Kobuk was found to be a clear mountain stream, about 100 yards in width. According to reports of the natives and of Lieut. Cantwell, however, it is not navigable far above this point, owing to its rapid ramification into numerous branches, which head in the rugged mountains to the north. Except for a few local sections near its headwaters in the first fifty miles of its course, the Kobuk can be easily descended by canoe or small boat. Three-quarters of a mile below Chekayakaka Creek occurs a rapid, through which boats can be lined with care; but a few miles farther down, the river passes over a small fall, rendering a portage necessary. Below the fall occurs a cañon, 1½ miles long, in which the stream channel is filled with large boulders, but can be run by a canoe with skill and care.

Eighteen miles below this occurs the lower cañon. It is about a mile in length, presenting difficulties at its lower end only. From this point to its mouth, a distance of 360 miles, the Kobuk is navigable for small boats without difficulty and for the lower three-fourths of this distance by steamboats.

The Kobuk valley, throughout its lower course, is 15 or 20 miles in width, but much narrower in its upper part. Just above the Chekayakaka high mountains close in upon it, and it becomes a typical mountain stream, with torrential gradient and cañon walls rising directly from its banks. Down as far as a short distance below the lower cañon the valley is from 5 to 10 miles in width. Here its floor is composed of folded and metamorphosed sediments of various types. Into this bed-rock floor are cut the cañons above described, which seldom exceed 100 feet in depth, and mark an uplift of the region, and consequent revival of the drainage, subsequent to the formation of the valley floor. Below the lower cañon the valley gradually widens, and for much of the distance is occupied by unconsolidated sands and gravels. The stream in its meanders, however, swings sometimes to the north wall and sometimes to the south wall of the valley. These walls are sometimes composed of the metamorphic rock series which makes up the great Trans-Alaskan mountain range on the north, and, running from the Mulgrave hills eastward, forms a more or less continuous range to the international boundary; and in part of unaltered sediments overlying and derived from the older metamorphic rocks. In short, the Kobuk river occupies a great strike valley, which is probably synclinal, though but little evidence was secured as to the geology of the southern wall.

GAME AND TIMBER.—Game, including moose, caribou, bear, geese and ducks, is more or less abundant between the Yukon and the Koyukuk, about the headwaters of the Dall river and Old Man Creek; also good timber, principally spruce, abounds in this region. In the Kobuk region, however, game is scarce, consisting essentially of a few bear, with some caribou and mountain sheep in the hills to the north. This scarcity seems to be the reason why the Kobuk natives repair annually to the Koyukuk drainage to hunt. The whole of the Kobuk valley, except the lower part of the delta, is timbered; the prevailing tree is black spruce, with occasional groves of birch and cottonwood. Alder and willows of various kinds line the streams and overspread the moist mountain slopes.

NORTHERN ALASKA AND THE ARCTIC COAST.

The work in this unknown region, in charge of W. J. Peters and G. P. Phillip, topographers, and F. C. Schrader, geologist, consisted in making a reconnaissance survey through the middle of northern Alaska, approximately along the 151st meridian, from the upper Koyukuk district on the Arctic Circle to the Arctic coast at the mouth of the Colville river, from whence observations were continued along the coast northwestward to Point Barrow, thence southwestward by way of Icy Cape to the Corwin and Cape Lisburne coal fields near Cape Lisburne, in latitude approximately 68½ degrees.

Owing to the remoteness of the region, the unexplored character of the country, and the uncertainty of transportation by reason of the Arctic ice pack on the north and the extreme shortness of the season, this work was probably the most difficult and hazardous of any ever undertaken by the Survey in Alaska. Plans for reaching this unexplored part of the Territory were already considered as early as 1897, but, for the reasons above noted, reached no satisfactory conclusion without involving the wintering of a party in the region at great cost and loss of valuable time. A solution was materially aided when the discovery of gold in the widespread Klondike region in 1898 and 1899 led to the location of a couple of trading-posts in the region of the Arctic Circle on the Koyukuk river, nearly 500 miles above its mouth, and the subsequent annual visitation of these posts by boats of reliable companies with supplies.

The outfit, including canoes and supplies for the season's work, was accordingly shipped from San Francisco in 1901, and stored in cache at the Bergman post on the Arctic Circle until called for by the Survey parties in 1901.

ITINERARY.—As the success of this work required the surveyors to reach the field before the break up of winter, and Point Barrow by

September 1st, the parties set out from Skagway early in February and after proceeding over the coast range by the White Pass railway, travelled from White Horse down the Yukon, a distance of 1,200 miles, by dog sled to Bergman, which was reached April 10. This means of travel, in the language of the country, is known as *mushing*, and the traveller or individual as a *musher*. Mushing does not consist of riding on the sled, which is used for carrying the absolutely necessary supplies and luggage only, but of following on behind the sled afoot, and urging the dogs forward or running ahead on snow shoes to break a trail where none exists or it has been drifted over, as is frequently the case. To keep trail-breaking and friction in travel at a minimum, the dogs are all hitched at tandem, from five to nine in a team. Their feed, which is given once a day, usually at night, consists of some cereal, meal or flour, cooked with meat, fish, or grease. Rice and bacon, flavoured with a little dried salmon, is best. It is also contended by experienced and reliable prospectors throughout Alaska that on arduous prospecting trips, where a man is dependent for sustenance on the food supply packed on his own back, he can go farther and accomplish a greater amount of hard work on rice and bacon than on any other ration.

In mushing at the present day in Alaska two classes of dogs are in use, the *inside* or native, consisting of Siwash and Malemut, and the *outside*, consisting of various breeds of imported dogs, principally from the United States. The outside dog excels in intelligence, and is usually desirable for a leader; but the native dog is best for all-around service and for long, hard trips, as he requires less food and care, and having a dense pelt, much like that of a wolf, is less affected by the severity of the climate, hardship, and exposure. He is also less liable to become footsore on a trail of rough ice and freezing slush. In mushing, the best progress is made in relatively cool weather, at a temperature 10 or 12 degrees below zero. As the atmosphere warms, under the midday sun, the dogs, especially the native, pant and become tired or lazy, and cannot be urged. On a long trip, under reasonable conditions, 25 miles a day is a good average day's drive. In one instance, where the trail was good, 46 miles were covered by the Survey party in a single day. The mail carriers on the lower Yukon are known in some instances to have made as high as 60, the record of the Yukon country.

During the past two years, mushing in the upper Yukon has been rendered less arduous by the so-called road houses, consisting usually of a log cabin and dog kennel, located at points a fair day's drive apart. Though the accommodations at these places are of the most crude order, at the rate of $1.50 per meal, they facilitate travel by affording the weary musher much-craved shelter and rest, and in lessening the amount of outfit and supplies he is compelled to lug in so primitive a method on a long journey. Where there are no road houses, as was the case beyond Fort Yukon, the traveller at the end of the day's drive selects his own camp spot for the night, and, unless provided with tent and stove, digs a hole through a depth of three or four feet of snow to the ground for a fireplace in which to cook. As a shovel is rarely carried, the snow in this act is scooped out with an axe and snowshoes. In sleeping on the snow and ice, spruce boughs form a desirable mattress where available. A light-weight tent with broad-bottom flaps and closing entrance, besides affording protection from storm and cold, is important in keeping the dogs from piling up on one's bedding and self while asleep, in which act they are wont to take unlimited licence on a cold night. Similarly, a light-weight sheet-iron stove, suited for cooking inside the tent, is very desirable, but not so indispensable, as an outdoor fire is usually required to cook the dog feed.

After doing some triangulation and topographic work in the Koyukuk valley, principally between the Arctic Circle and the 67th parallel, the party waited at Bergman for the disappearance of the snow and ice—the "*break-up*," as it is called, for the sheet of soft snow or slush, several feet in thickness, which everywhere overspreads the country during the thaw period of spring renders travel of every kind impossible. Owing to the heavy snowfall of the previous winter and the lateness of spring, the break-up period of 1901 was of unusual length, extending from the middle of May to June 6, or lasting about 25 days. During this time some astronomical observations and other investigations of a local nature were made.

The breaking up of the ice on the Koyukuk, as observed at Bergman, differed but little, if any, from that observed on most of our large rivers in the northern United States. As the stream beneath the ice became swollen and distended, the ice along the middle of the river was gradually bulged up or raised into a low arch, which by the 26th had risen four or five feet above its normal level and subsequently higher, the edges being still frozen fast to the shore. In the meantime the excess of water, increased by the surface drainage, unable to find passage beneath the ice, formed broad streams, several feet in depth, flowing on the surface of the ice between either side of the arch and the shore. These conditions increased until the 29th, when at 2.30 P.M. the ice, now visible in the middle of the river only, broke or parted and almost bodily moved ⅛ mile down stream, when it was stopped by a jam; but at 6.30 it again started and moved about a mile. Soon after this, with increased rise of water, a general breaking up of the ice took place, and it continued to run more or less steadily until June 6, when the river cleared and became navigable for steamboat. So far as observed, the ice rarely exceeded 2½ feet in thickness, the lack of greater thickness being probably due to the protecting heavy mantle of snow. Permanent ice usually forms on the river by October 10.

It is readily conceivable that the arching feature of the ice at the time of the break-up in the Arctic regions may exceed that in less frigid climates, owing to the firmer anchorage of the edges of the ice, being frozen fast to the shore and the shallow riparian portions of the river-bed. The Koyukuk is susceptible of great rise and flooding; but, so far as known to the white men, the maximum has resulted from heavy autumn rains.

After the break-up, the party proceeded by river steamboat 80 miles up the Koyukuk to Bettles, a new supply post near the 67th parallel. From here, commencing June 13, the work was continued northward 100 miles with Peterborough canoes up a large tributary of the Koyukuk, the John river, to its headwaters, thence by a five-mile portage (2,500 feet above tide) through the mountains to the upper waters of the Anaktuvuk, the large east fork of the Colville, flowing northward to the Arctic coast. These rivers were descended by canoe and the coast reached August 15. The ice on the Colville is reported to have broken up July 16. From here, after a considerable portion of the Colville delta had been mapped, the work was continued 100 miles northwestward by canoe along the coast to Smith Bay. Here, owing to the lateness of the season, stormy weather, and rough surf incident thereto, the plane table work was dropped and transportation continued to Point Barrow, with Eskimos in native walrus skin boats, as these were found to be far more seaworthy and to sail better than the canoes. Point Barrow was reached September 3rd, where it was hoped passage to the States might be procured on some whaler; but on learning that all such vessels had long since departed, and that the ocean was expected to freeze up within a week, September 10 being the usual date, supplies and a whaleboat were procured, in which the party proceeded southwestward along the coast, hoping to catch a whaler several hundred miles farther south at Point Hope, where one was expected to touch to leave her native crew. By exceptional good fortune, however, on September 19, at the Corwin coal fields, some distance above Point Hope, the steamer *Arctic* was met with, which kindly transported and landed the party at Nome, on September 26, whence passage to Seattle could be readily procured on any of the numerous Alaskan steamers.

METHODS OF WORK.—As the Koyukuk did not break up until early in June, and the expedition, to be successful, was obliged to reach Point Barrow early in September, the season of work was limited to a period of less than three months, during which 500 miles had to be travelled. As it was impossible to make more than from three to seven miles a day up the swift waters of John river, it became necessary to make almost daily advances. To accomplish even this required the united efforts of the entire party. Consequently, many mountains could not be climbed that could have afforded opportunity for more extensive topographic sketching. The methods here used are a new combination of plane table triangulation and tacheometry, being largely the ideas of Mr. W. J. Peters, in charge of the work. At intervals of about ten miles, prominent points adjacent to the river were ascended for topographic sketching on the plane table. Two stone cairns or monuments, about six or seven feet high, were left on each of these points to mark the ends of the base which was to be used in determining the distance to the next station. The next station was usually selected before the base was marked, so that the base might be laid off at right angles to the next station, or as near to the right as the shape of the summit would permit. The direction of the base was always projected on the plane table sheet, so that the angle between it and the line to another point could be measured. The length of the base was from 300 to 600 feet, and was chosen with regard to the estimated distance and direction of the next station so as to subtend an angle of about 22 minutes, which was measured with the micrometer screw of the alidade.

Between stations a traverse of the river was made with prismatic compass and stenometer. The plat of the traverse was transferred to the plane table sheet and fitted to the located points. The orientation of the plane table was controlled by the azimuths, determined with the theodolite when necessary.

This method of plane table locations was followed from Bergman to twenty miles beyond the summit, and, judging from intersections on points on either sides of the route, it was satisfactory and sufficiently accurate for the publication scale of the exploration map now in course of preparation. The compass and stenometer were used from twenty miles beyond the summit to the end of the traverse on the Arctic coast. The rapidity of travel, and the absence of high or prominent points along this part of the route, prohibited further use of the above plane table methods. Latitudes and magnetic declinations were obtained when the weather permitted.

GEOGRAPHIC.

THE KOYUKUK RIVER.—The Koyukuk drains the northwestern part of the Yukon basin. It is one of the largest tributaries of the Yukon, which it enters on the north, about 450 miles above its mouth. It has a very large drainage basin, which, as already noted, heads to the west of the Chandlar basin, in the Trans-Alaskan mountains, in the northeastern part of Alaska, near the 69th parallel and the 150th meridian. From that point its axis trends southwestward through a distance of more than 300 miles direct toward the head of Norton Sound to the Yukon, giving to the river a length of approximately 700 miles. It is navigable by steamboat to Bergman, a distance of 450 miles above its mouth, and at high water to Bettles, 80 miles farther. Besides the South Fork, the principal tributaries, five or six in number, each approximately 100 miles in length, head in the Trans-Alaskan mountains to the northwest, and are received above the Arctic Circle. In its upper part, near the edge of the mountains, in the region of the Arctic Circle, the Koyukuk basin has a width of nearly 150 miles. Here the valley becomes broad and open, and is largely occupied by a gently rolling plateau country, which has a general elevation of 2,000 feet, being about 1,000 feet above the river. Northward this plateau character gives way to hilly inter-stream areas and ridges, which merge into the foothills of the mountains on the north.

MOUNTAINS.—In the vicinity of the 68th parallel the work traverses a rugged range of mountains which was found to have a width of approximately 60 miles and an elevation of 6,000 feet. This range is supposed to be the northwestward continuation of the Rocky Mountains of the United States and British Columbia, which here trend nearly east and west across Alaska, forming the great Trans-Alaskan watershed between the Yukon on the south and the drainages of the Arctic Ocean on the north. It was not expected to find these mountains extending in such force so far to the westward. At present there seems to be but little doubt that, as a pronounced orographic feature, they continue, though with decrease in elevation and width, through to the west coast in the vicinity of Cape Lisburne. In the region of the 152d meridian the north edge of the mountains lies about 150 miles from the coast. East of this, however, it curves strongly toward the north-northeastward, so that in the region of the 147th meridian the mountains lie quite near the coast.

On the south the rise from the rolling Koyukuk country to the mountains is by foothills, but rapid. On the north the mountains break off abruptly, much as they do along the edge of the Great Plains in the western United States. Faulting and uplift are evidenced by marked deformation of the strata and the presence of prominent fault scarps, sometimes of considerable extent.

A view across the top of the range has the appearance of a dissected plateau, whose former surface is denoted by the sea of peaks which, in general, rise to 6,000 feet, while the valley floors lie approximately at 2,000. The range seems to be somewhat higher near its northern and southern sides than in its middle portions.

The drainage of the range is principally southward into the Koyukuk. John river, the stream ascended, rises near its northern edge and flows almost entirely through it. The master drainage ways in this part of the Territory are therefore of a transverse character, extending across the strike and trend of the rocks as well as transversely to the trend of the range, while the tributaries to these larger streams nearly always flow along the strike and enter the master streams at right angles.

The rocks composing the range consist of several metamorphic series of limestones, slates, and schists, apparently much older than those forming the rolling plateau country on either side of the range, Toward the north side there are also sandstones, conglomerates, grits, and limestones, some of which are Paleozoic.

PLATEAU AND COASTAL PLAIN.—Along its northern base the range, at an elevation of 2,000 feet, is met by a gently rolling plateau country composed of Mesozoic rocks, which, with gentle slope, extends northward a distance of 100 miles, from which point the profile, continuing 75 miles farther northward to the Arctic coast, traverses a nearly flat tundra country or coastal plain, underlain by late Tertiary beds several hundred feet in thickness. In the plateau country the valleys are shallow and open, with no well-defined banks, while in the inland portion of the coastal plain, though the valleys continue open, the river banks are well defined. Along the coast portions of the edge of the coastal plain are fringed by tidal lagoons and embayments and dotted by lakelets. It is not rare here, in low bluffs and sea-cliffs, to find ice taking the place of geologic strata, rising to a height of twenty feet above sea-level and extending inland for unknown distances. Much of the topography of the plateau country in aspect has been softened by the presence of glacial deposits, showing the ice-sheet to have extended 100 or more miles northward from the mountains.

TIMBER.—A moderate growth of spruce and cottonwood extends up John river into the mountains to near the middle of the range. Here the timber-line occurs approximately at 1,600 feet. From this point to the coast the only representative of timber is the willow. It is usually much dwarfed or stunted in growth, rarely large enough to furnish a tent-pole. Toward the coast, if present at all, it becomes a mere shrub, less than knee high, or is limited to the trailing variety, with only the points of the leaves appearing above the moss. At various points along the coast drift timber, washed ashore in embayments, is used by the natives for fuel. So far as observed, the coast is totally barren of timber from the mouth of the Colville down to beyond Cape Lisburne.

FISH AND GAME.—No fish to speak of were noted on John river, though trout occurred in some of its tributary streams. They also occur in the Anaktuvuk river and some of its tributaries. On the lower Colville, and at various points along the coast, the principal fish of the natives seems to be a whitefish. It is usually caught by net, and, so far as observed, is probably not abundant. In the mountains along John river, mountain sheep and caribou are present, and form a principal food supply of the natives. At certain periods of the year caribou are hunted as far north as the coast. A few bear are present in the mountains, and polar bear are frequently taken by the natives along the coast. Among birds the ptarmigan is probably the principal for all seasons of the year, but during the latter part of the summer ducks are taken by the coast natives in very large quantities.